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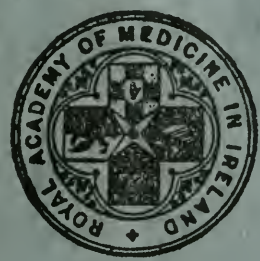
FORMERLY

THE DUBLIN JOURNAL OF MEDICAL SCIENCE

THE OFFICIAL ORGAN OF THE ROYAL
ACADEMY OF MEDICINE IN IRELAND

EDITED BY

A. K. HENRY, M.B., F.R.C.S.I.



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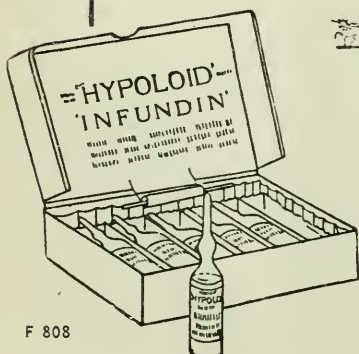
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FIFTH SERIES. No 10. DECEMBER, 1922

Original Communications

“WHAT MAKES FOR SUCCESS IN
SURGICAL TREATMENT.”*

BY SIR W. I. DE C. WHEELER.

I WONDER if my predecessors in the Chair of the Surgical Section of the Royal Academy of Medicine in Ireland, or those who presided over the old Surgical Society, were guilty of the same half-conceit which stimulated me a few days ago to take down volume after volume of the *Transactions* of the Academy and the old numbers of the “Dublin Journal,” to reflect on the names of those who have gone before.¹

I knew well, without reference, who I would find in the great procession—Colles, Butcher, Porter, Tufnell, Bennett, Ball, Stokes, Swanzy and Edward Taylor—to mention just a few of those who have left their footprints behind. I would like to add the name of my own father: at all events, through

* The Opening Address to the Surgical Section, Royal Academy of Medicine, Nov., 1922.

him I have had a long acquaintance with this Surgical Section. He was President when I was five years old. I broke my arm, and he brought Mr. Butcher to see me. He was known in those days as the Butcher's Boy. I remember a conversation as to the proper title of a paper which was to be read at an Inaugural Meeting of this Academy, and I heard discussions between him and Mr. Butcher on the triumphs and failures of surgery. The title of his paper when opening this Section in 1883 was, "What Society has Gained by the Progress of Modern Surgery." My ambition in life has been to keep the surgical flag, under which I was reared, still flying, but when it came to my turn to form up in a distinguished procession of Past Presidents, both living and dead, for obvious reasons, my courage waned.

Barry gave his Rectorial Address on the subject of Courage at St. Andrew's University, in May last. It commenced thus:

"You have had many Rectors here in St. Andrew's who will continue to bloom long after the lowly ones such as I am are dead, rotten and forgotten. They are the roses in December. You remember someone said that God gave us memory so that we might have roses in December. But I do not envy the great ones. In my experience, and you may find in the end it is yours also, the people I have cared for most, and who have seemed most worth caring for—my December roses—have been very simple folk. Yet I wish that for this hour I could swell into someone of importance, so as to do you credit."

The title I have chosen for my Address embraces so much that I must only touch on the fringe, and briefly indicate the general direction of surgical progress. Those who follow me as speakers from the other Sections of the Academy will criticise and fill in the gaps, and it is good for us surgeons to hear the considered views of those devoted to the allied branches of our craft. The distinguished President of the Gynæcological Section has set us an example in that.

If I was asked to say, in one or two sentences, what is essential for successful surgical work, I would first quote a saying which was posted up on the walls of a Dublin day

school I used to attend—"Trifles make Perfection," and "Let me tell you that Perfection is no Trifle." Next in importance comes simplicity. In the craft of surgery, says Moynihan, the master word is simplicity: but, above all, team work or group work is essential to carry out modern methods. It is just as easy for a single general in the field, without the aid of a staff of experts, to control aircraft, tanks, artillery, transport, and all the paraphernalia of modern warfare, as for a surgeon (or physician for that matter) to undertake single-handed the many complexities of even a simple case. There was a time when individuals counted in the profession of medicine, as in the profession of arms, but that day is over. The field-marshal and the surgeon must have a thoroughly trained staff, the co-ordinated brains of which are used in the solution of every problem. Of course, the brains must be good. It is said that the Duke of Wellington, when inefficient staff officers were sent to his side, remarked: "I do not know what effect these gentlemen will have on the enemy, but, by God, they frighten me!"

The best team work of a limited kind I ever saw was twenty-two years ago, when I visited the Continental Clinics with Mr. Haughton and Dr. Halahan, and a little later in a visit to the same centres, when we were accompanied by Dr. Dobbin and the late Mr. Edward Taylor. Team work sufficient for good work was seen in selected centres in England, and it excelled in Edinburgh, especially in the non-teaching hospitals, when I was a student. The training of nurses and students in a hospital undoubtedly works against efficiency, but it has its compensations, and students and nurses must be taught.

What is meant by team work? I will answer by saying what is not meant. Consultations, as we know them, have no connection with the modern conception of team work as applied to a surgical case. Sending portions of pickled meat to a laboratory at a distance, and placing reliance on the report received—the surgeon never seeing the pathologist, and the pathologist never seeing the patient—is an insult to modern thought. It is a dangerous practice, unfair to the patient, to the pathologist and to the clinician in charge. Such methods have no place in co-ordinated clinical effort

but clinicians are to blame if they are content with counterfeit coin. I think perhaps medical pathology, leading up to vaccine therapy, is better understood than the modern conception of gynæcological pathology and surgical pathology as it exists in the living.

If time permitted, I could give you many examples of how the detachment of the pathologist from the clinician and the clinician from the pathologist has led either to disaster, or nearly to disaster, in the management of a surgical case.

Two years ago ² I was privileged to give some impressions to this Section from visits to the clinics of outstanding surgeons on the Continent and at home, visits paid every summer since I was qualified until war broke out in 1914. I pointed out how it was . . . "difficult to understand at first why the late Professor Kocher of Berne stood head and shoulders above his neighbours and colleagues, men apparently with equal opportunities and a corresponding amount of grey matter." Kocher was a superman, but also a type of surgeon well represented in England, Scotland, France, in our own country and elsewhere. Unfortunately there were others.

"In one clinic an immense amount of operative work would daily be completed. One case after the other would reach the operating room as if those responsible for the preparation and anæsthesia could see through closed doors and always be ready at the psychological moment. Seldom at the operation was it found that an incorrect diagnosis had been made. The physician, radiologist, biochemist, and all concerned were generally present to watch their observations put to the test. One could see the wheels working in a well-oiled machine. A visit would be paid the next day to some other clinic. A few words to the surgeon perhaps would leave the impression that the coming performance was to be headed by a genius. But in this case the anæsthetic was not taken well; after the first abdominal incision the recti fought against further interference and there was a delay: or after opening the abdomen the intestines made efforts to escape, as a result

of incomplete anæsthesia or improper pre-operative preparation. The *x*-ray photographs did not correspond with what was actually found, some vital point in the blood or urinary examination had been omitted, and those from whom information was required were not forthcoming. When finally the next case was expected in the theatre there was confusion, hurried orders, and the third patient appeared instead of the second. It is just the difference between the work of a well-trained team and the incoordinated action of isolated and often incapable individuals."

It is unreasonable for us in this city to expect, within any measurable time, to reach such a state of perfection as is to be found in Rochester, U.S.A., but let us remember that the population of that city is only about 8,000, and the vast medical organisation was built up by the efforts of two men. This feat was accomplished by constant travel and the exercise of a well-balanced judgment on the part of those two Mayo brothers who were determined that the best from the surgical world should be imported into their own domicile.

Those who have had an opportunity of visiting Rochester will remember that—

"Once a week post-mortem examinations are made, and every doctor concerned in the case must be present. The patient may have died after gastrectomy for cancer of the stomach. There is evidence perhaps that the *x*-ray picture was misleading. The radiologist is present and explains the fallacies of his critics. How was it in this case—cancer following chronic ulcer—that no hydrochloric acid was found at one examination and on the same day hyperchlorhydria was reported on the chart? Those responsible come forward and give details of numbers of cases where secretions of hydrochloric acid is inhibited at the time of testing, perhaps from the sight of the tube, perhaps in relation to the time of the last meal. Hence the frequent necessity of fractional gastric analyses and tests at quarter-of-an-hour intervals when the results of such an examination are considered of importance. So

the discussion at the post-mortem goes on, until finally the cause of death is attributed to, say, infection at the line of anastomosis, and the onus is placed then on the surgeon to explain why, in this case, he adopted an operative technique which had failed."

I cannot see the difficulty in imitating such admirable methods.

So much for the idea, in outline, underlying team work. It can be carried on without extra staff and without extra cost, to a sufficient extent, at all events, to change antiquated and defective into modern and safer methods.

I think our salvation lies in travel, and that those who are coming on to take our places should be encouraged to see the world before undertaking appointments on the staff of a hospital. Travel gives a rude awakening to those who suffer from the soporific effect of self-contentment and self-esteem.

As experience grows, one is impressed with the fact that, to reach satisfying results, equal care must be taken of the patient before, during and after operation. While our minds are taken up with operative technique and diagnosis, other important issues must not be forgotten.

Carey and others,³ following on the work of Crile, advise the alkalisation of operation cases.

After referring to Crile's theory of acid intoxication, and discussing the connection between acidosis and shock, he insists that the body fluids must be preserved, and the alkali reserve must be maintained. He concludes emphatically that the giving of alkalies before operation lessens post-operative discomfort, that catheterisation is required less frequently, and that "gas pains" are reduced to a minimum.

The Sisters in Mercer's Hospital in charge of the wards have the following written instructions in connection with the patients under my care:—

Preparation Before Operation:

1. 20 grains of bi-carbonate of soda every four hours for two or three days if necessary, until urine is alkaline.

2. Large quantities of water by the mouth, or saline by rectum, for the 10 or 12 hours preceding operation.
3. In anxious cases, or in children about to undergo bone operations, glucose to be given if possible for two or three days before operation.
4. No enema on morning of operation.
5. No laxatives to cause purging in patients preparing for operations. Simple laxatives, as in non-operative cases, are alone necessary a day or two before.
6. Special instructions to be given in cases of intestinal cancer.

Patients After Operation:

1. Unless restricted from some special reason, such as fracture of bones, etc., the patient may move as much as he likes in bed from the first after operation.
2. The patient may sit up out of bed on the second or third day after ordinary operations, provided they are not drainage cases and there is no fever.
3. The freedom of the room to be given after four days; a bath after seven days, and out for walks or drives not later than the tenth day.

Rowlands ⁴ holds that many of the dangers of operations are due to unnecessary restrictions. He says, very truly, that complete rest in bed depresses the spirit and lowers the physiological actions and general vigour of the body; the heart beats less frequently and less forcibly, breathing becomes slower and shallower, the appetite fails, the digestion flags, the bowels become more sluggish. Under these conditions thrombosis and pulmonary embolism are more likely to occur. It is easier to avoid the formation of a clot than to prevent it shifting. As regards the healing of wounds, complete rest is unnecessary, and even harmful, by interfering generally with the local circulation and nutrition. Hernia does not follow early and gentle exercise. Children and infants are difficult to keep still, and yet heal and recover better than adults.

I was operating in Mercer's Hospital a few days ago when a doctor strolled into the theatre whose gall bladder I had

removed ten days before; he was up and about five days after operation.

It is not suggested, says Rowlands, that patients should be rushed back to work, or that one patient should be treated, of necessity, in the same way as another. Obviously, after removal of the thyroid gland in a case of Graves' disease—of which I have two instances at the moment in Mercer's Hospital—the whole plan of management is different to a case of simple appendicitis.

All surgeons are agreed that prolonged convalescence and dieting for two or three months are necessary after gastro-jejunosotomy for active ulcer, but only the first few days of this period need be spent in bed.

In Zurich ⁵ the routine treatment of surgical cases is along these lines. It is recognised there that the mere fact of lying in bed for any considerable number of days produces, in itself, an illness. The day following operation the patient is up, and again it is emphasised that no cases of ventral hernia follow clean abdominal cases subjected to this treatment. It is fallacious to think that early movement after operation causes non-union of the wound; Experience shows the reverse to be the case. It is possible that something analagous to Wolff's Law operates in the case of the soft tissues.

Again from Zurich comes the belief that preliminary purging is scientifically unsound, and if this is combined with enemata on the morning of operation, the patient starts at a distinct disadvantage. Sir Berkeley Moynihan ⁶ supports this view.

"Solid food," he says, "is much like liquid food by the time it gets well on its way in the jejunum. As much fluid as the patient wishes to have should be allowed to within an hour or two of the time arranged for any operation, and as soon as possible afterwards. Operations on the stomach are no exception. An enema generally clears the colon quite as much as is necessary. Aperients increase the number and the virulence of the intestinal micro-organisms, and are apt to deprive the patient of a large amount of fluid and to cause exhaustion: effects which are all most undesirable."

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Brisk purgation before, and sips of water after, is a sure way of adding to discomfort and, to some extent, to the dangers of operation.

The temperature of the operating theatre requires attention. Should the theatre be hot? I follow Rowland's⁷ advice, and arrange for a temperature of about 65 degs. Fah., with good ventilation, and the avoidance of excessive moisture. Shock is probably more severe after operation in unduly hot and stuffy operating theatres. The patient perspires, and gradual evaporation from the surface of the body results in perhaps considerable loss of fluid. But, apart from these considerations, and the dangers of pulmonary complications arising from rapid change of temperature, it is worth mentioning the effect of excessive heat on the surgeon and his assistants.

It is pointed out that Leonard Hill and others who investigated the causes of industrial fatigue proved that the capacity for work rapidly diminished in a temperature rising above 65 degs. Fah., and that a vitiated atmosphere laden with moisture adds to the bad effect of heat. "A surgeon and his assistants working under such conditions cannot give their best work, however anxious they may be to do so."

I do not like to labour this point, although personally I operate in a comparatively cool theatre, and have no reason to regret it. Surgeons of the past decade were powerful advocates of the hot theatre, and they seemed to enjoy puffing and blowing in a lather of perspiration. Are we slaves to this example, as in so many other matters? Is the very hot operating theatre merely a hallowed tradition which is very difficult to destroy? or is it beneficial and useful?

Apropos of the temperature of the operating theatre, pulmonary complications in connection with operations should be mentioned. To send the patient from a hot theatre along a cold passage into a moderately heated ward is asking for trouble. The least one can do, under such circumstances, is to see to it that the patient's head is covered over with a blanket in order to prevent the inhalation of cold, unfiltered air.

The relationship between abdominal operations and subsequent chest complications is regarded of late in a more

clear light. It is recognised that the diaphragm is the piston of respiration, and that anything which interferes with its descent may cause œdema and congestion of the lungs. The late J. B. Murphy wrote some illuminating articles on this subject; and recently Wilkie⁸ has called attention to the frequency with which crepitation is found at the base of the right lung in cases of acute gall bladder trouble. In my experience, this pulmonary sign is not confined to acute conditions in the gall bladder, but may follow any acute condition, including post-operation conditions, in the right upper abdomen.⁹ This is due to the fact that the diaphragm will not descend. The pulmonary condition clears soon after the first thorough evacuation of the bowels.

It is very difficult to distinguish between an acute upper abdomen associated with crepitations at the base of the lung and commencing pneumonia with referred pain. We are apt to jump to the conclusion that pneumonia is commencing when crepitations are distinctly heard.

Four times in the last eighteen years I have experienced the tragedy of pulmonary embolism in my practice. Three of the four were private cases. The operations were all of a simple kind, and, in the generally accepted sense, there was no infection.

Most surgeons have experience of this calamity at one time or another. It cannot be foreseen, nor, to any certain extent, prevented. Does morphia before operation, the Trendelenberg position during operation, or the Fowler position after operation, create a tendency to thrombosis in those past the prime of life? Children are immune, and it seldom follows operation above the diaphragm.

Attention has been drawn recently to all these points.¹⁰

Gordon Watson says:—

“ If we do not reduce a patient to pulp before operation or allow him to bleed at operation, or fail to be generous with fluid after, we shall at any rate not impoverish his blood supply. If we avoid strained positions at operation and fixed positions after; if we stimulate respiratory and muscular effort during convalescence, we shall do no harm, and perhaps avoid disaster.”

I have left to the end the most fascinating part of all these considerations—I mean what Moynihan refers to as “the Ritual of the Surgical Operation.”

We could go to the operating theatre with a light heart if we were certain that not only a perfectly smooth running technique was in waiting, but also if we had deeply ingrained in our mind the belief that the ultimate effect of the procedure would be followed by cure. How often do we have some misgivings as to the amount of permanent relief our perfect operations will provide. This is the acid test of a successful operation. It is melancholy to hear it said of anyone that he is well content with his results, that the wounds never become infected, that the theatre Sister—however unsuited for her post—is an angel from heaven, and that a change of technique for the better is impossible. There has always been the inevitable make-believe that the hands of the surgical clock can remain stationary. Men are content to live with their heads in the sand, and by a process of Coué-ism satisfy themselves that their own methods represent the finality of perfection.

It is a strange thing, but many still think that infection does not occur if suppuration is not apparent. Sir Berkeley Moynihan's writings are inspiring on this subject. In speaking of results, he says:—

“ . . . A surgeon may be a prejudiced witness as to his own efforts, and a bad judge of his own merit. When we speak, for example, of ‘healing by first intention,’ what do we mean? What is our standard? Let us take extreme examples. In the one we mean a wound which heals within a few days, leaving a thin, straight, narrow line of palest pink. Across this line and the stitch marks everything appears ‘cold.’ There is no redness, no swelling, no stiffness or induration, and at the line itself the most accurate apposition of skin edges is seen. There is no discharge from the wound. There has been neither local nor constitutional reaction following the operation. In the other, we mean a wound which is anything but straight: the edges are jagged, they do not meet accurately at every part, they overlap here and there: the line of

healing is broad and irregular, raised and red, a sticky discharge oozes from the unapposed surfaces, and a scab may lie where this discharge has dried. The parts around are raised, tender, doughy or stiff. The stitches seem to sink into the skin. You may see wounds of this kind in some clinics, and hear a complacent comment that the wound was healed by 'first intention.' Such wounds are the clearest evidence either of a bad technique or of a clumsy operator, or perhaps of both.

"Surgery should be a merciful art. The cleaner and the gentler the act of operation, the less the patient suffers, the smoother and the quicker his convalescence, the more exquisite his healed wound, and the happier his memory of the whole incident, to him probably one of the most important in his whole life."

It is a delight to quote Moynihan, who is a master mind on the subject of technique. He has shown that although a visitor is gowned, masked, and his head covered with a cap, nowadays, in all hospitals, that the organisms from dirty boots and soiled trouser legs, if the wearer moves about freely in the theatre, are scattered broadcast, as the simplest experiments have proved. Large canvas overalls for the boots and the lower part of the legs will afford ample and secure covering to these possible sources of infection. He ridicules, as did Kocher before him, the common practice of washing hands in a basin of still water. The moment the hands are soaped and rinsed, the water is polluted by the dirt washed off the skin. If the washing is continued, it is obvious that the hands are being constantly infected by the contaminated water, and it is really not uncommon, he says, to see a piece of soap used to lather the hands being laid down and picked up again. Washing under running sterile water is the simple effective method.

In the early part of 1914, I was in Liverpool when the "Lusitania" arrived with the late Dr. J. B. Murphy on board. He was on his way to visit the English surgical centres. We travelled together for four or five days: what an education it was to listen to this giant in surgery, whose fame had spread into every land. After watching some of

the larger bone operations at this time performed by Sir Robert Jones, I wondered why we general surgeons had not long before thought of clamping off the skin edges with sterile towels, as was practised in this famous Liverpool Orthopædic Clinic. Here were we surgeons covering up every part of the patient with sterile sheets, except the skin round the wound, with which our instruments and hands were in constant contact. There was the underlying idea no doubt that treatment of the exposed skin with germicides rendered it sterile for perhaps an hour on end. Those of us who used tincture of iodine for preparation were in greater danger of failure than others who used more effective agents, such as picric acid or brilliant green. Since my lesson from Murphy and Jones in 1914, towels have been fixed to the wound edges and no portion of skin exposed during operation. If the bacterial effects of iodine on the skin are tested, and to do this it is necessary to remove it by a solution of potassium iodide and wash with sterile water in the first instance, infection, according to Moynihan, can be demonstrated in over 50 per cent. of the cases. Tincture of iodine after washing of the skin with alcohol is my own preparation, but on recent bacteriological reports I intend to give it up. Culture tests of iodised catgut, just as culture tests of iodised skin, may be negative even in the presence of contamination unless certain precautions are taken, but on this subject others are more fitted to speak. I believe there is no such thing as "timed" catgut; the rate of absorption depends *inter alia* on the amount of tension under which it is introduced.

Scratches across the skin made with a fine needle at right angles to the intended line of incision, show us the points to introduce the sutures with mathematical accuracy. Without this mathematical accuracy there is never perfect beauty in the wound. For my own part, I use the finest and lightest instruments obtainable, and when vessels are clipped I try to avoid including the mass of tissues surrounding them. A strangled tissue needs digestion by leucocytes in the wound, with some reaction and discomfort to the patient.

An instrument steriliser should boil within easy reach of the operation, so that instruments such as the knife, clamp,

scissors and inverter, used in removing an appendix, may be re-sterilised before again touching the sheets within the operation area. It is difficult to get perfect healing in our general hospitals as organised to-day. I do not mean healing "by first intention"; that is easily obtained; but may be very imperfect. I mean the healing of a wound without any local or general reaction whatever, followed by a convalescence with little or no pain or discomfort.

We all have seen cases after major operations such as resection of the colon, gastrectomy, and so forth, sitting up in bed discussing current topics and reading the newspaper on the morning following operation.

Crile speaks of carnivorous surgery; Moynihan refers to those who operate upon the principle of "canine attack"; we all know the breed which advocates work with one eye upon the clock.

In Blackrock Orthopædic Hospital, where we had our septic cases isolated as if suffering from the plague; where the best theatre sister and nurses were selected because of a splendid record of efficiency and training, and were never changed, and where, by common consent, a miniature team became established, we were able to obtain results which I, for one, cannot obtain in the rough and tumble of a small teaching hospital. Really good results in the strictest sense can be obtained in private practice if the surgeon insists upon the patient having the best obtainable from his (the surgeon's) point of view: all other considerations must be turned down. It requires a surgical gymnast to operate one day in one place and the next day in another, with the consequent change of the attendant personnel. No one except a juggler can do justice to surgery under such conditions.

Time does not permit me to dwell on the wonderful effect of combining local anæsthesia with general anæsthesia as a routine in surgery. Apart altogether from Crile's fascinating theories about the prevention of shock,¹¹ which I saw him put into practice two years ago, the fascial divisions and minute anatomical structures are rendered plain and distinct, perfect relaxation of muscles is assured, and if the method is thoroughly carried out, the after effects of nerve blocking are

admirable. For twenty years following a lesson from Kocher I have used the method almost as a routine.

My last word is to urge the necessity for us all in the common cause to throw the search-light on the defects in our work and in the institutions in which we work. By constantly drawing attention to conditions which are a handicap and thwart our intentions and ambitions, a remedy may be found. There is splendid surgical and medical work at present carried out in this city, but let the splendour lie in subdued light for the moment; it is the dark and dusty corners which require illumination. The plan of emphasising defects in our surroundings does not lead to popularity, but we can say of unpopularity what has been said of jealousy: "It is the tribute paid to youth for successful enterprise in thought or in action by minds which suffer from the atheroma of advancing years."

In the commencement of my address, I mentioned the names of many who, by loyal, thoughtful and unceasing work in the days of individualism, have left us a legacy to be prized; but I see another group represented here to-night which will see to it in the face of all difficulties that Irish surgery takes the same honoured place in the future which it deservedly occupied in the past.

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SOME OBSERVATIONS ON THE ENTERIC-SALMONELLA BACILLI.*

BY W. D. O'KELLY.

AT the opening meeting of the Section of Pathology last year I expressed my thanks to the Fellows of the Academy for the honour conferred on me in electing me to the Chair. I take this further opportunity of thanking them. In the past year many interesting communications and demonstrations were given to this Section. I sincerely hope that the same standard will be maintained in the coming year. I must apologise for the delay in bringing forward this Address arising from the pressure of other work, and to the same cause I must attribute many of its shortcomings.

Of all groups of bacteria perhaps the Typho-Coli group stands out as the most interesting. Embracing, as it does, many sub-groups covering a very wide range, from bacteria of economic value to organisms second only to those causing Cholera and Plague in their virulence for man, this group is of very great importance to the agriculturist, the pathologist, and the clinician. New organisms, fresh symptoms, more selective isolation-media, modifications of serum-reactions, and attempts at more accurate typing are described very frequently. So extensive has the literature dealing with these organisms become in recent years that it would be impossible for me to do more than review a portion of the latest work on some members of the group in the time at my disposal to-night. I trust that my choice of the Enteric-Salmonella organisms will meet with your approval.

A very comprehensive survey of the literature was given by Bainbridge (1912) in the Milroy Lectures on Paratyphoid

* Presidential Address delivered at the Opening Meeting of the Section of Pathology, Royal Academy of Medicine, Ireland, Session 1922-23.

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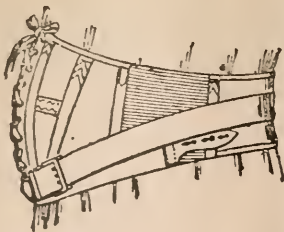
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Fever and Food-Poisoning, but much work has been done since at home and abroad which requires careful consideration.

The Enteric Group.

The bacteriology of the Entericas is usually regarded as comparatively simple. Three organisms are concerned:

1. *B. typhosus*—A definite type, responsible for the greater number of cases of enteric fever.
2. *B. paratyphosus A*—Stated not to occur in Great Britain or Ireland, but found in a certain number of enteric cases on the Continent, and commonly met with in India and in the United States. The organism has been isolated in Ireland, but not from an enteric patient. Peacocke (1911) reported to this Academy three cases of septic fingers occurring in nurses attached to the Adelaide Hospital. One of them developed biliary colic, which eventually called for operative interference. From the bile and urine of this patient an organism was recovered which proved to be *B. paratyphosus A*. The sera of all three cases clumped this organism in a dilution of 1-40. Unfortunately, the strain has not been preserved. This is the only record of *B. paratyphosus A* infection in this country which I have come across.
3. *B. paratyphosus B*—The common cause of paratyphoid fever in these countries. Its incidence would probably be about 5 per cent. of cases of enteric fever, but no records are available with regard to its frequency in such cases in Ireland, a fact which is much to be regretted.

To these three organisms must now be added a fourth, *B. paratyphosus B* (Hirschfeld), or, as Hirschfeld called it, *B. paratyphosus C*. It has been chiefly isolated in the Balkans and Mesopotamia during the European War, and subsequently. It has been isolated once in England. Further reference will be made to this organism.

The Salmonella Group.

I have selected the term *Salmonella* as the least confusing to apply to a group of organisms which has given

rise to a considerable amount of controversy. The terms Gaertner and Paratyphoid are also frequently used. Two views have prevailed with regard to the members of this group. First consider Bainbridge's standpoint. The group comprises :

1. *B. enteritidis* Gaertner—giving rise to outbreaks of food-poisoning, being culturally indistinguishable from *B. enteritidis* Aertrycke or *B. paratyphosus* B, but sharply separated from them by agglutination. It is commonly found in sick cattle, and gives rise to epizootics in rodents.
2. *B. enteritidis* Aertrycke—also causing outbreaks of food-poisoning and culturally indistinguishable from *B. paratyphosus* B and Gaertner's bacillus. It is only to be distinguished from *B. paratyphosus* B by absorption, simple agglutination tests being insufficient. It is often found in the alimentary canal of swine.
3. *B. paratyphosus* B.—causing a mild enteric fever and only occurring in man.
4. *B. paratyphosus* A.
5. *B. Suipestifer* *—regarded by Bainbridge as identical with *B. enteritidis* Aertrycke.
6. Various other organisms, such as *B. typhi murium*, *B. icteroides*, *B. psittacosis*, and several organisms employed as rat-viruses, such as *B. Danysz*.

“ Nothing is to be gained,” says Bainbridge, “ by retaining this somewhat confusing array of different names for the same organisms, and it is simpler and more accurate to consider the Salmonella Group as consisting of only four organisms, *B. paratyphosus* A, *B. paratyphosus* B, *B. enteritidis* Aertrycke vel, *B. suipestifer*, and *B. enteritidis* Gaertner.” This position is very definite. It regards the behaviour of these organisms in agglutination and absorption tests as sufficient for the determination of their identity. Besson (1913) accepts Bainbridge's work, but prefers to

* Bainbridge's strains of *B. suipestifer* were all of German origin.

exclude *B. paratyphosus* A from the group, an exclusion which is pretty generally accepted, and has much to recommend it.

The German view differs markedly from the foregoing. True, they describe the same organisms. They are rather definite in putting Gaertner's bacillus in a separate class, but in their literature the term "*Gaertner-paratyphus*" occasionally crops up. With regard to the other two organisms, for they regard the *Aertrycke* and *suipestifer* bacilli as identical, their plan of naming the strain isolated from a case or in an outbreak is usually zoological. If of human origin, it is called *paratyphoid*, if of animal origin, *suipestifer*. This system is not rigidly followed, and strains of animal origin are frequently called "*paratyphoids*." Furthermore, they do not admit that there are any real cultural or serological differences between these organisms. Certain cultural differences are, they say, often recorded, but these differences are no greater than may be found between individual members of a sub-group if a large number of strains be studied. They make a similar observation on the differences brought out between various strains when their agglutinating properties are investigated. The absorption test they discard as affording no real criteria for differentiation, provided the tests are carried out with a number of strains. With regard to such organisms as *B. typhi murium*, they content themselves with stating their cultural and serological relationship with other members of the group.

The Bainbridge school would obviously reply that as this method of naming an organism was somewhat loose it was clear that if, for example, an animal strain was labelled *B. paratyphosus* B, and then the identity of another organism determined by agglutination with an anti-serum prepared with this organism the whole value of agglutination as a method of differentiation in the group would be lost. In other words, what the Germans would call a number of strains of *B. paratyphosus* B would include organisms regarded by Bainbridge as *B. suipestifer*.

Some of the confusion which exists may be due to incorrect labelling, or to cultures supplied as pure not being really so. Thus Bainbridge (1909) studied an organism sup-

plied from the Pasteur Institute, Paris, as *B. Danysz*, and found it to be culturally and serologically *B. paratyphosus A*. Also an organism sent him by Prof. Loeffler as *B. typhi murium* turned out to be a mixture of Gaertner and Aertrycke, and a similarly labelled culture from Král proved to be a mixture of Aertrycke and *B. paratyphosus B*. Clearly the use of such cultures from the production of anti-sera would give rise to the utmost confusion. Certain recent work has helped to clear up some obscure points, and may be briefly referred to.

Cultural Characters of the Salmonella Group.

As is well known, the *Salmonella* organisms are differentiated from other members of the Typho-Coli group by their behaviour on media containing certain "sugars." In the interpretation of the value of sugar tests it must be borne in mind that recently-isolated or "raw" strains may fail to ferment certain sugars until they have been subcultured, perhaps repeatedly, and that loss of fermenting power is sometimes noticed after prolonged subculture. A few examples may be cited. Savage and Forbes (1918) isolated a Gaertner strain which formed acid, but no gas, in dulcitate and mannite. When subcultured for a time acid and gas production was recorded. Similarly Pleasance (1922) described an organism which was a very bad gas-former and dys-agglutinable for a long time. It eventually behaved like a typical Aertrycke. Again, when testing the strain of Gaertner isolated by me from an outbreak of food-poisoning last year and a number of allied organisms on certain sugars, I found that the "raw" strains at first formed neither acid nor gas on arabinose, and the Limerick organism, also a Gaertner organism, gave only acid. On repeating the test with subcultures the "raw" strains had acquired the power of forming acid and gas from this substance, whilst the Limerick strain again only produced acid. Arabinose would appear to be a substance towards which certain members of the *Salmonella* group vary in their behaviour. Indeed some German bacteriologists have attempted to subdivide Gaertner organisms into those not fermenting and those fermenting arabinose, but this claim

has not been sustained, those not accepting the view stating that the fermentation of arabinose was not an important characteristic of these organisms. On the other hand, the Americans claim that *B. suipestifer* does not ferment arabinose, whilst Aertrycke strains do, and they argue that these two organisms cannot be regarded as identical. They find also that their *suipestifer* strains do not produce H_2S from certain substances, whilst Aertrycke does. The Germans say that all *Salmonellas* possess this power.

It may be argued that certain organisms isolated in the United States from the intestines of pigs suffering from swine-fever do not occur in Europe, but apparently certain strains isolated in cases of swine-fever in Poland are culturally very closely related to, if not identical with, *B. suipestifer*. It is thus apparent that as the result of the study on culture media of a larger number of strains permanent differences may be brought out in certain organisms at present considered identical. Some of the more important cultural reactions of the organisms under consideration are given in Table I., p. 458.

Pathogenicity.

It is well known that the *Salmonella* organisms are virulent for laboratory animals, several being actually responsible for epizootics amongst them. Tenbroeck (1920, *a* & *b*) has worked out the virulence of some of these organisms and their protective immunising powers against hog-cholera strains. The position is as follows:—*B. suipestifer* is extremely virulent for rabbits, as compared with the other members studied. Rabbits may be immunised by what he terms "swine-typhus" organisms, or animal paratyphoids, against a lethal dose of *B. suipestifer*. Hirschfeld's paratyphoid C organism protects against ten times as high a dose as will the animal paratyphoids. The human paratyphoids (Schottmüller strains) did not protect. We see, therefore, that by considering the virulence and powers of cross-immunisation four distinct types are got. As Schütze (1921) has confirmed these findings and determined that Gaertner in addition affords some protection against *B.*

TABLE I.

Group.	Type.	Habitat.	Causes in man	Lactose	Glu- cose	Man- nitic	Ara- bin- ose	H ₂ S	Dul- cite	Xyl- ose	Milk	In- dol	Sali- cin
Salmo- nella	Suispastifer	Intestine of swine	Gastro- enteritis	—	AG	AG	—	—	— or slow	AG	A Alk.	—	—
	Hirschfeld	Intestine of man (and swine)	Enteric type of fever	—	AG	AG	AG	+	AG	AG	A Alk.	—	—
	Aertrycke	Intestine of swine	Gastro- enteritis	—	AG	AG	AG	+	AG	AG	A Alk.	—	—
	Schottmüller	Intestine of man	Enteric fever	—	AG	AG	AG	+	AG	AG	A Alk.	—	—
	Gaertner	Oxen and rodents	Gastro- enteritis	—	AG	AG	AG	+	AG	AG	A Alk.	—	—
Enteric	B. Paratyph B	human intestine	Enteric fever	—	AG	AG	AG	+	AG	AG	A Alk.	—	—
	B. Paratyph A		Enteric fever	—	AG	AG	AG	—	AG	—	A (Alk.)	—	—
	B. Typhosus		Enteric fever	—	A	A	—	+	— or A	A	A (Alk.)	—	—

Note: In the Salmonella group, Schottmüller is identical with B. Paratyphosus B in the Enteric group. Also the Aertrycke type is taken as covering such strains as Mutton, Stanley, Newport, etc., to avoid repetition.

A = acid formed; + = formation of H₂S; A = acid formed at first; then

G = gas formed; — = not formed or no change; Alk. = reaction becomes alkaline.

supestifer the relationship between these types may be tabulated as follows:—

TABLE II.

SALMONELLA GROUP (AFTER TENBRUECK).					
Type.	Virulence for Rabbit	Protection by cross-immunisation	Culturally	Serologically	
Suieptifer	Very high	—	Distinct	identical	
Hirschfeld	slight	high	identical	distinguished by absorption	
Animal paratyphoids		moderate			
Human paratyphoids		nil			
Gaertner		slight		distinct	

If this typing is found to hold with a large number of strains it will do much to simplify the existing confusion. Possibly the American *suipestifer* does not occur in Great Britain or Ireland, and this may explain some of the discordant results obtained by various bacteriologists.

Observations on Agglutination in the Group.

Bainbridge held that *B. paratyphosus* B and *B. Aertrycke* were only to be distinguished by absorption of agglutinins. It is universally admitted that Gaertner stands out sharply from these two organisms by agglutination alone. Experience has shown that the serological relationship existing amongst the *Salmonellas* is by no means so clear. For example, McWeeney (1916) recorded that a strain of *Aertrycke* isolated by him from a fatal sporadic case of gastro-enteritis could be distinguished from *B. paratyphosus* B by simple agglutination, and the existence of such strains is now pretty generally recognised. Perry and Tidy (1919) recorded agglutination experiments conducted with some *Paratyphoid* and *Aertrycke* strains. The *Aertrycke* stock strains were Mutton and Newport. An agglutinating serum prepared with Newport agglutinated Mutton and Schottmüller to full titre. When tested against a Mutton anti-serum the *Aertrycke* and Schottmüller organisms only reacted to about one quarter of the full titre.

Schütze (1920) subsequently studied some members of the group. Clinical and cultural differences were put aside and their serological behaviour was examined in detail. He not merely compared the mirror agglutination properties of the organisms, but also used the mirror absorption test, and found that these tests were not merely useful in bringing out differences between certain strains, but were sometimes necessary to establish serological relationship. He found that there were at least nine serological types of the organisms usually termed *B. paratyphosus* B and *B. Aertrycke*. In a more recent paper (Schütze, 1921) he has added in a tenth type—*B. abortus equi*. This organism, however, differs markedly in its growth on agar from the other types in the group. Schütze would therefore consider the *Salmonella* group as made up mainly of Gaertner and Para-

typhoid organisms, the latter being sub-divided into at least ten serological types—Schottmüller, Mutton, Stanley, Newport, Hirschfeld, etc.

* The German experiences in serum-tests on members of the Salmonella group are far from clear. The work of Schmidt and Zeller, quoted in Kolle and Wassermann's Handbuch (1913), may be taken as an example. A large number of strains were tested and they resolved themselves into three distinct sub-groups.

1. Strains agglutinating strongly with an anti-serum prepared from a calf-strain, and agglutinating weakly with a human paratyphoid anti-serum.
2. Strains agglutinating strongly with a human paratyphoid anti-serum and weakly with a calf-strain anti-serum.
3. Strains not influenced by either of these anti-sera in high dilutions.

Schmidt and Zeller further noted that the agglutinability of human paratyphoid strains by calf-strain anti-sera (which they call a paratyphus-serum) was considerably increased when they had been for a long time in the body of a calf, and at the same time their titre for their own serum was lessened. Human strains were thus no longer agglutinated as such, but as Gaertner strains, and the blood of calves infected with these originally genuine paratyphoid B organisms possessed the agglutinating power of a Gaertner-serum. This change was not observed with all the strains. Many retained their true paratyphoid characters. If the organisms referred to were genuine Schottmüller strains then one of two things must have occurred—mutation by passage or isolation of Gaertner from the calves and failure to recover the inoculated micro-organism. In this connection it will be recalled that Gaertner infections in calves are not infrequent.

The preceding paragraph illustrates the difficulties which arise in the Salmonella group, and also the confusion existing in the German literature with regard to the naming of the organisms. This confusion is not altogether got over by supposing that the organisms are identical and the names interchangeable. If that were so, why comment on a human

paratyphoid strain becoming serologically a Gaertner strain, or again, it may be asked if this did occur and the change is a sharp one, why did not all the strains behave similarly after passage? In considering the German work it must be remembered that the number of strains examined is very large, and that while certain prominent bacteriologists in one area, who, no doubt, have done a considerable amount of work on the *Salmonella* group, hold very decided views on the relationship between the members of the group, these views are not universally accepted in Germany.

The most interesting serological work on the *Salmonella* organisms recently published is that of Andrewes (1922), dealing with its antigenic structure. Andrewes started off with a mono-specific agglutinating serum prepared by saturating an ordinary anti-serum of high titre with a number of organisms allied to the homologous strain. Such a serum will only agglutinate the homologous organism. He next studied 16 strains of Jensen's calf-paratyphoids which were by agglutination Aerttryckes, and the majority of which failed to agglutinate with a Schottmüller serum. Isolated colonies were then picked off from agar plate-cultures of each of these strains, and in every case a colony was obtained in which the organisms agglutinated freely with a Schottmüller serum—even higher than they did with their own mono-specific serum. This result led to the study of several *Salmonellas*, and Andrewes found that by plating-out an agar and picking off isolated colonies two serological types of each organism could be obtained:

1. A type agglutinating with the mono-specific serum, but not with the group-serum—the specific serum.
2. A type agglutinating with the group-serum and reacting weakly with the mono-specific serum—the unspecific type.

Of 118 strains examined in this way (raw and stock strains were tested) only once was a colony which appeared to be intermediate in type met with. When these colonies were subcultured the specific type did not necessarily remain specific. After the first subculture in broth it might become an unspecific or a mixed type.

Arising out of Andrewes' work it would appear that if,

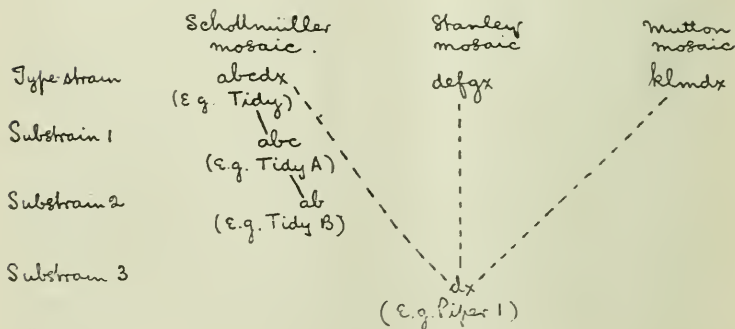
for example, a specific colony of Aertrycke was subcultured and this culture used for the preparation of an agglutinating serum, such a serum would not agglutinate a Schottmüller strain to any extent (or not at all if the culture being tested were the specific type), whereas the degree of agglutination for an Aertrycke strain would largely depend on whether a culture of specific, unspecific or mixed type was employed. If, on the other hand, an anti-serum were prepared with a broth culture of an unspecific type of Aertrycke and this serum was used by two bacteriologists to test what titre it agglutinated a Schottmüller, one worker would get a negative result if using a specific type, the other would find the same organism agglutinated to a fairly high titre if he used an unspecific type. Such a possibility may account for some of the discordant results published, and it is evident that it can only be eliminated by avoiding subculturing from isolated colonies or by using mono-specific sera. Indeed it is surprising that the confusion resulting from the possibilities mentioned without the observer being aware of them has not been very much greater. At most one occasionally sees it stated that individual rabbits may not afford satisfactory anti-sera. Here Bainbridge (1909) and Tenbroeck (1920 *a*) may be cited. One fact familiar to every bacteriologist is apparently explained by Andrewes' work, that is the presence of many free motile bacilli in a Widal preparation in which marked agglutination is taking place.

Twenty-three years ago, McWeeney (1899) drew the attention of this Section of the Academy to the fact that raw strains of the typhoid bacillus may be comparatively inagglutinable, and therefore of little value in the Widal reaction. This phenomenon is not by any means constant, but the agglutinability of a recently-isolated organism does undoubtedly increase after a period of subculture.

Gardner and Walker (1921) have published an article dealing with the agglutination of *B. typhosus*. One of their strains, a motile organism, gave on plating-out colonies of motile and non-motile bacilli, and these varieties behaved serologically as different types. Another peculiar experience is that of Topley, Weir, and Wilson (1921). They were working with a strain of Gaertner's bacillus. They selected

colonies started from a single bacillus and found that they agglutinated with an Aertrycke serum to full titre, but only to a very much lower titre with a Gaertner serum. Andrewes' work perhaps explains how such a result might occur.

Schütze (1921) divides the Salmonella organisms into two groups. Gaertner and Paratyphoid. The latter is subdivided into ten types, as already mentioned, Schottmüller, Mutton, Hirschfeld, and supestifer being those most frequently met with. He admits that the subject is difficult, but claims that it is fair to regard those serological types as correct if the existence of what he terms "sub-strains" is accepted. A "sub-strain" is a strain in which the antigen mosaic is defective. It will agglutinate partially with the serum of a normal strain and absorption of its own serum by a normal strain completely absorbs it. Schütze found that an organism might give rise to more than one sub-strain. Thus the Tidy strain, a normal Schottmüller, gave rise to two sub-strains, Tidy A and Tidy B, the relationship between which was much the same as that between a normal strain and a sub-strain. He also found that the mosaic of a sub-strain might be so degraded that it could be regarded as portion of more than one type. The sub-strain Piper 1 behaved as such a sub-strain, and we may attempt to represent the relationship of such strains diagrammatically, using letters to denote their mosaics, somewhat as follows:



This diagram assumes, although it is not actually stated by Schütze, that Tidy A and Tidy B are not related to Piper 1, that is, the latter is not a sub-strain of the Tidy sub-strains. If it were, then obviously the Tidy sub-strains would also be sub-strains of the Stanley and Mutton types.

Two of the most recent papers on the Salmonellas published in Germany may be taken as illustrating the trend of opinion in that country. Gaertner (1922) comes to the conclusion that clinically, anatomically, and on epidemiological and bacteriological grounds the organisms of paratyphoid fever can be distinguished from the gastro-enteritis paratyphoids. In other words, he accepts Tenbroeck's division into human and animal paratyphoids. He adds in the Gaertner organisms as forming a third group. Supestifer he does not discuss.

Mannteufel and Beger (1921) go somewhat further. They used absorption in addition to simple agglutination-tests. They consider it essential that strains should be tested to determine their stability, and they used such "test-strains" for the production of anti-sera. They found that the ass yielded a more reliable anti-serum than the rabbit. Employing such a serum prepared with *B. paratyphosus* B, they came to the following conclusions:

1. Supestifer strains were practically not agglutinated by this serum.
2. Saturation of this serum with supestifer organisms removed no agglutinin.
3. Saturation of this serum with Gaertner strains left agglutinins for Schottmüller and Flugge-Kaensche strains.
4. Saturation of this serum with Flugge-Kaensche strains left agglutinins for Schottmüller strains only.

These findings recall Schütze's sub-strains. Thus supestifer would be the lowest in the scale and Schottmüller the type strain.

Mannteufel and Beger seem a little doubtful about the interpretation of the absorption tests with the Schottmüller and Flugge-Kaensche or Breslau strains (Tenbroeck's animal paratyphoids), the strains amongst which the greatest difficulty arises.

Clinical Considerations.

One would like to present a series of definite pictures of the clinical conditions brought about by the Enteric-Salmonella organisms. Briefly, the enteric organisms give rise to attacks of continued fever, the Aertrycke, Gaertner, and suipestifer organisms to gastro-enteritis. Certain peculiarities and exceptions must be considered. Achard and Flandin in the French Supplement to the *Lancet* in 1918 * pointed out that epidemics of typhoid and paratyphoid fevers occur at the same time, and state that during the European War in the epidemics in the French Army sometimes Eberth's bacillus, sometimes one or other of the Schottmüller organisms predominated. "It has consequently been asked," they say, "if this co-existence does not result from the three infective germs ordinarily finding themselves united in the same infecting materials, such as drinking-water or food contaminated with dejecta." They cite cases of infection with *B. paratyphosus* B in the father and with Eberth in the daughter, of pulmonary congestion due to *B. paratyphosus* B in a typhoid patient, and due to *B. paratyphosus* A in a case of paratyphoid B fever—cases which are no doubt very rare, but nevertheless difficult to explain on any hypothesis but that which they postulate. It is that what occurs is an *enteric* epidemic, typhoid fever usually predominating. From one or more of the cases a small monomicrobial outbreak occurs in the midst of a great polymicrobial epidemic.

Bainbridge (1912) mentions that *B. paratyphosus* A is recorded as having given rise to gastro-enteritis. Bainbridge and Dudfield (1911) have described an outbreak of gastro-enteritis due to *B. paratyphosus* B, and recall two similar outbreaks reported (in these latter outbreaks absorption tests were not employed). Boxwell (1916) reported a case of gastro-enteritis in which Schottmüller was recovered from the stools. The patient subsequently developed a few rose-spots, and the spleen became enlarged.

Concerning sporadic cases of Gaertner infection in man, Dean (1911) described a case of suppurative cholangitis in a

* Vol. II., page 393.

carrier. Gaertner's bacillus was recovered from the gall-bladder, although there was no history of gastro-enteritis. Savage and Duncan Forbes met with an outbreak of gastro-enteritis due to Gaertner in which the source of infection was a kitchen-maid, a carrier of the organism. Rosher and Wilson (1921) report a case with pulmonary symptoms of influenzal character simulating typhoid fever. The patient's serum clumped Gaertner in a dilution of 1-3200. Gaertner was not recovered from the blood or fæces. The sputum was not examined for this organism. They mention in their communication that they had at the same time in hospital a patient with a prolonged illness due to the Mutton type of Aertrycke. McNee (1921) describes a fatal case with symptoms of broncho-pneumonia like severe influenza, in which convulsions and nephritis developed. Gaertner's bacillus was isolated from the sputum. McNee states that in typhoid and paratyphoid fevers with bronchitis (not broncho-pneumonia) he has frequently recovered the Eberth and Schottmüller organisms from the sputum. In this connection we may recall Sir Humphry Rolleston's (1922) statement that "enteric fever, thanks to sanitary science now comparatively infrequent, sometimes imitates common influenza, and bacteriology may show that what clinically appeared to be influenza is in reality enteric fever."

The foregoing examples are sufficient to show that the rôle of the individual members of the Enteric and Salmonella groups is not as sharply-defined as was once believed. Schottmüller may cause gastro-enteritis, and Gaertner and Aertrycke continued fever, facts of the greatest importance in the spread of disease.

Prevention.

The prevention of enteric-salmonella infections may be summed up in a few words. Locate the carrier and then see that infection of the food does not occur. But the food is very commonly the flesh of the carrier! The animal may be ill when slaughtered, or dissemination of the organisms may only occur after accidental contamination in the abattoir. In either event the flesh usually shows no macroscopic alter-

ation, and would be passed as fit for human consumption. It is equally troublesome to ruin the human carrier to earth. The problem usually arises during an outbreak, when the observer's hands are already full. Again, when one considers the bacterial content of the fæces and the small amount used for cultivation it is not surprising that many carriers are not detected. Larger quantities of fæces should be examined and enrichment methods in fluid media given a more extensive trial. In every case the urine should be examined,* and apparently the sputum should receive more attention. Difficulties will crop up—a non-motile strain of the typhoid bacillus, perhaps. Should this organism be also dys-agglutinable it would probably be discarded. Very atypical strains may in this way be met with. In stock cultures we may regard them as freaks, but they occur in the raw state. Walker (1922) has described dys-agglutinable varieties of *B. paratyphosus* B got occasionally by repeated sub-culture of eu-agglutinable strains in media containing specific agglutinating sera. One of these strains became mucoid and formed colonies which resembled soft candle-grease and which slipped down the surface of an agar-slant like the “ guttering ” of a candle. These strains were mostly non-motile and highly dys-agglutinable with an ordinary paratyphoid anti-serum, but could be brought back by degrees to behave like a normal strain. Now Fletcher (1920) has described capsulate mucoid forms of paratyphoid (and dysentery) bacilli which he isolated from the fæces of carriers. They resemble the strains described by Walker and the colonies would be readily passed over, as Fletcher points out, in the ordinary “ fishing ” for non-lactose fermenters of the Enteric-Salmonella groups as unlikely to repay investigation. Also we know that organisms may be trained to ferment carbohydrates, and when such trained strains are plated-out on media containing these sugars they commonly yield two varieties of colonies—fermenters and non-fermenters. McWeeney has met with a strain which behaved somewhat after this manner as a “ raw ” strain. The organism was isolated from a non-lactose-fermenting colony on an agar-

* Andrewes and Neave state that Hirschfeld's organism is more frequently met with in the urine than in the blood or fæces.

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plate sown with faeces. On plating-out these non-lactose-fermenters they yielded fermenters and non-fermenters. When the latter were plated-out colonies of fermenters and non-fermenters again appeared.

B. paratyphosus C.

A few remarks on *B. paratyphosus C* and I have finished. The name was first applied by Uhlenhuth to an organism isolated from the animal intestine which was in its general cultural behaviour a *Salmonella*, but serologically distinct from *B. paratyphosus B*. Hirschfeld (1919) described an organism, culturally a *Salmonella*, causing paratyphoid fever in the Serbian Army and serologically not related to *B. paratyphosus B*. Eight of his cases had received T.A.B. vaccination. He called the microbe *B. paratyphosus C*, and added this organism to the enteric vaccine in use, after which he met with no further cases amongst the troops. About the same time Macadam (1919) isolated a similar organism from cases with enteric symptoms in Mesopotamia. Some of the patients had lobar pneumonia without enteric lesions, and respiratory symptoms were usually a prominent feature of the disease. The organism at first did not clump with Schottmüller or Aertrycke sera, but subsequently agglutinated, though not to full titre. Schütze (1920) found that some Hirschfeld strains were agglutinated by a Schottmüller serum, others not, any doubtful results being cleared up by absorption. Andrewes and Neave (1921) studied some strains of the Hirschfeld group and found that some of Uhlenhuth's paratyphoid C organisms are serologically related. They divided *suipestifer* into two groups. Group I. strains absorb the sera of Groups I. and II. Group II. strains only exhaust their own sera. These groups remind us of Schütze's type and sub-strains. Hirschfeld strains belonged to Group I. They also found, as did Macadam, that these strains might or might not agglutinate with a Schottmüller serum when first isolated, but did so after subculturing. Lastly, Tenbroeck (1920 *b*) found two strains of Hirschfeld's organism were serologically identical with *suipestifer* (even by absorption), were not virulent for rabbits, in the hog-cholera sense,

and afforded a good deal of protection against suipestifer when employed for vaccination of rabbits.

I fear that I have gone into the relationship of these organisms to one another and their bearing on disease in man at very great length; but the subject does not lend itself to condensation. It may seem that I have emphasised the difficulties, but it is such matters that really count. The views of the English and German bacteriologists appear to be nearing agreement and to have much in common with those prevailing in America, but many controversial points await solution. We want to know whether the human paratyphoids are distinct organisms or merely animal paratyphoids modified by passage. The position of the rat-viruses is similarly unsettled. Information is also needed as to how far cultural and serological differences are permissible in different strains, how far these characters may be altered by passage through various hosts, and whether such alterations are of a permanent or temporary nature. I sincerely hope that some of our Irish bacteriologists will undertake a portion of this work.

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OIL-ETHER COLONIC ANÆSTHESIA BY THE CONTROL METHOD.

BY ALFRED E. BOYD.

ON April 9th, 1920, I read before the Surgical Section of the Royal Academy of Medicine in Ireland a paper describing a modification of Gwathmey's method of etherisation by the introduction of a mixture of ether in olive oil into the colon.* The solution used was much weaker than that employed by Gwathmey, and the technique of administration more simple. The advantages claimed for the method were its safety and its simplicity, combined with the marked placidity of respiration and absence of mucous secretion which characterised the anæsthesia, during its course, and the lengthy period of analgesia which supervened.

In none of the cases, less than thirty in number when the paper was written, in which it had been used, was the percentage of ether in oil greater than 50 per cent., and none had shown the untoward symptoms reported as having occurred when strong solutions of 75 per cent. to 80 per cent. had been employed—*viz.*, respiratory failure during the course of anæsthesia, or the passage of blood by the rectum, say, within forty-eight hours of operation.

The method has now passed into routine use at the Richmond Hospital in such cases as colonic etherisation appears desirable, and it seems right that the results of more extended experience should be published, and that the modification of technique which has resulted should be recorded.

I append a record of over 130 cases in which it has been used. Most of these cases were operated on at the Richmond Hospital, and anæsthetisation was in the charge either of myself or of Dr. A. B. Clery, my colleague, to whom I am very grateful for the help which he has given in recording the results of the cases which have passed through our hands.

* *Dublin Jour. Med. Science.* May, 1920.

In dealing with the cases, the procedure at present adopted is as follows:—

PREPARATION OF THE PATIENT.

The patient is weighed.

Weight is the governing factor in regard to dosage. The standard strength of the mixture is 50 per cent. of ether in olive oil. In some cases, where the patient is unusually robust, a 60 per cent. solution may be used, but in general it is wiser to use a 50 per cent. solution and depend on the control by oral inhalation for the maintenance of anæsthesia. Safety first, is a useful maxim.

The weight of the patient having been ascertained, the dose to be administered by the bowel is one ounce of the solution for every twenty pounds body-weight of the individual—thus, a ten-stone patient receives seven ounces of the mixture.

Eight ounces is about as much as can be administered by the bowel without risk of the solution being returned.

On the night preceding operation the bowel is washed out; this should be done thoroughly. On the morning of the operation a simple enema is administered and the patient left as much as possible at rest.

The psychic factor is of importance, and all needless worry to the patient should be avoided. Hence, if practicable, he should be removed from the general ward to a secluded room on the day before operation. If this be impossible, the bed should be placed in the quietest position in the ward and screened.

TECHNIQUE OF ADMINISTRATION.

At least an hour before the time fixed for operation, morphia gr. $\frac{1}{6}$ —gr. $\frac{1}{4}$ c atropin gr. $\frac{1}{150}$ —gr. $\frac{1}{100}$ is administered hypodermically—preferably the smaller dose in each case.

This preliminary medication should be omitted in the case of children, and of those who are dull, lethargic or semi-comatose.

Ten minutes or a quarter of an hour after the hypodermic injection has been given, the ordered quantity of oil-ether

solution is passed slowly and continuously into the colon through a soft rubber catheter connected with a tube and tundish. The catheter should be passed as high as it will travel without force. The patient lies on his side in bed. He should never be placed on the trolley before the injection is given. Should the subject be restless or excitable, paraldehyde 3ii may be added to the oil-ether solution.

The injection should be completed in about twenty minutes. The catheter is then disconnected from the tube and tundish and is left *in situ*, a clip forceps being applied to it to prevent leakage from the bowel. This is desirable, as some of the solution may return if the catheter is withdrawn.

Experience has shown that from half an hour to forty minutes is ample for the process of absorption of ether vapour from the mixture in the colon, and that to delay the completion of anæsthesia by the control for a longer period is to run the risk of wasting the available anæsthesia from the colonic source. Absorption of ether vapour from 50 per cent. solutions appears to cease in about two hours after the injection.

The injection being completed, the patient is left at rest, the bed is screened and the blind pulled down: the nurse in attendance keeping within easy reach, but preferably out of sight. Usually the patient becomes drowsy rapidly, sometimes muttering in an amiable confusion, and then passes into a light sleep. Two cases in the series became noisily drunk, and required the interference of the nurse. One, a girl, suffering from a brain tumour, who was delirious, promptly returned the injection. A subsequent administration, given very slowly, was retained and the case proceeded satisfactorily.

About half an hour after the injection has been completed, the anæsthetist approaches as noiselessly as possible. Some minims of oil of orange in absolute alcohol (ol. aurantii 25 per cent., alcohol absolute 75 per cent.) are dropped on the pillow—this masks the pungency of the ether vapour—followed by a few drops of ether. If the vapour is inhaled without causing resentment the mask is gently applied and open ether given until the onset of stertor.

This usually takes about five minutes.

When stertor is established the patient is lifted carefully on to the trolley and moved to the theatre. Usually the anæsthesia is deepened by keeping the mask over the face during transit. He is moved to the table, the final preparations for operation made, and the operation begins.

METHOD OF CONTROL.

Usually the mask is removed just before the surgeon gets to work, and the patient settles down to a placid anæsthesia characterised by an absence of mucous secretion. But it is an anæsthesia which tends to become lighter as time goes on. In this lies its safety; the method is under control. Sooner or later symptoms supervene calling for more anæsthetic—phonation, twitching of the muscles of the face, movement of a limb or retching movements in cases in which there is any traction in the throat. A few drops of ether applied for a minute or two tips the balance and placidity is restored.

The frequency with which resort must be had to the control varies greatly in different cases. In general, with spare and weakly cases, very little oral inhalation is necessary, while in the robust and plethoric recourse must be had to it more often. In any case the amount of ether administered by the respiratory tract is very small.

When the operation is finished, the patient is brought back to the ward and the bowel is washed out. When this has been done, three or four ounces of olive oil should be injected into the colon and the case left at rest. By this time he has passed into a state of analgesia, which usually continues for some hours after operation.

The technique of administration and of control has been dealt with at length, because on attention to detail the success of the procedure depends. *Technique is everything.*

Movement of the patient or noise in the ward, disturbance of any kind during the course of induction, breaks the syndrome and hinders the quiet transition from consciousness to anæsthesia which characterises the method, a transition in which the elements of excitement and fear usually are absent entirely.

Class of Cases to which the Method is Applicable.

Reference to the appended table will show that the cases in which it has been employed fall roughly into three classes :

1. The general surgery of the head and neck—growths, innocent and malignant, within or around the buccal cavity ; glands in the neck, and, in an especial degree, the goîtres ; plastic operations on the face and neck.
2. Operations special to the Throat and Nose Surgeon—radical operations on the sinuses and plastic operations on persons of adult age.
3. Cranial and brain operations—Craniotomy, Exploration of the Brain, Cerebral and Cerebellar growths, Decompression, Gasserian Ganglion.
4. Cases falling outside these classes are recorded at the end of the table, and mention will be made of the reasons which determined the use of the method in some of these.

1. In the surgery of the head and neck the advantages of a continuous anæsthesia characterised by an easy respiration free from mucous and capillary congestion and mucous secretion need not be enlarged upon. The anæsthetist is out of the way of the surgeon, and in intra-buccal operations is free to give a hand, if need arise, in keeping the air-way free from blood. In several cases of malignant disease of the tongue, maxilla or fauces, the actual cautery has been used to destroy the growth. Some of these patients were operated on repeatedly and were anæsthetised on each occasion by this method. Some of them were broken-down old men in whom the disease was far advanced. At first the application of the actual cautery was anticipated with a certain amount of anxiety. Ether absorbed from the colon is in part excreted during its passage through the lungs before reaching the centres. Would the exhaled vapour be of an ether concentration sufficiently high to exceed the flashing-point? Experience in a number of cases has shown that, working with a 50 per cent. oil-ether injection, it is not.

Operations on *tuberculous glands in the neck* are usually characterised by an abundant secretion of mucous when ether is administered by the respiratory tract. This is almost

entirely obviated by the method, while the fact that the ether vapour exhaled is at the temperature of the body eliminates the element of chill and lessens the danger of waking up a possible focus of tubercle in the lungs.

The Goîtres: The psychic factor is of such immense import in these cases that the advantage of producing anæsthesia while the patient is at rest in bed is very great. If the technique of administration is properly carried out there should be no rise from psychic causes in the pulse-rate, even in cases of pronounced tachycardia. The element of fear should be absent. The placid respiration characteristic of colonic anæsthesia is very marked in the goîtres, while the lengthy period of analgesia which supervenes after operation is a distinct advantage.

Ease of body and tranquillity of mind aid the recovery of these patients in a marked degree.

2. The general advantages noted before apply also to cases falling within the sphere of the Throat and Nose Specialist.

In *plastic procedures on the palate*, the even respiratory movement and freedom from spasm aid the surgeon in his work, while in *operations on the sinuses* capillary bleeding is reduced to a minimum.

In these cases the application of the control during the course of the operation should not be necessary, but, should need arise, a few drops of ether on a wipe held against the lower lip will suffice to maintain anæsthesia.

Working with a 50 per cent. injection, without preliminary medication with morphia, the anæsthesia should never be deep, and the laryngeal reflex should be present all through the operation.

3. Perhaps in no field of work are the advantages of colonic etherisation more marked than in that of *intra-cranial surgery*. Respiratory rhythm is uniform and of limited range, capillary hæmorrhage is slight, laryngeal spasm is absent. The posture of the patient, which impedes the anæsthetist who depends on inhalation methods alone, occasions but little difficulty when the colonic method is employed. In these cases it is advisable to dispense altogether with preliminary medication by morphia or paraldehyde if the patient is at all lethargic.

It has been the practice to infiltrate the superficial field of operation with novocain $\frac{1}{2}$ per cent. in order to block the peripheral nerve endings and lessen shock. No untoward effects arising from the use of novocain of this strength have been noted, although the area infiltrated has been extensive.

4. *General Surgery.* A few cases noted at the end of the table call for comment.

Laminectomy, the factor which determined the use of the method in these cases, was mainly that of posture.

Thoracoplasty—removal of F.B. and Endothelioma of Pleura. The use of the colonic method in these cases was opposed to the opinion expressed in my former paper, in which it was stated that "if the area of lung surface is reduced by collapse or by pressure it would seem that there would be an increased danger of over-dosage"—due to decreased elimination of ether during its passage from the colon through the lungs to the centres. Working with the standard strength, there was no over-dosage. The reasons for its use in intra-pleural work are the absence of laryngeal spasm and mucous secretion, and the maintenance of quiet respiration.

Breast Tumours. "Beware of the fat old woman!" is an old and true surgical adage. Many of the cases of breast tumours which present themselves for treatment are obese and wheezy. Frequently they are nervous. The use of colonic etherisation lessens the risk of post-operation bronchitis, and the terror of operation, which so often characterises the woman with a breast tumour, is diminished by adherence to the technique of administration.

Tubercular Testis and Tubercular Disease of Lungs. The emaciated consumptive who requires surgical operation has always been a problem. Ether inhalation may aggravate the pulmonary condition; chloroform, where the heart is small and central, is undesirable. Further experience is necessary before a definite opinion can be given as regards the safety of the colonic method in these cases.

Laceration of Urethra with Fracture of Pelvis and Femur. This was the case of a gentleman who had fallen from a racing horse, the horse falling back on him, fracturing his left femur and the pelvis, the urethra being torn. He had

been brought to Dublin after an unsuccessful attempt had been made to pass a catheter into the bladder. Five incisions had been made for the purpose of drainage, and the fractures had been dealt with. On his arrival in Dublin he developed pneumonia and operative procedure to deal with the urethra had to be postponed.

After some days the pneumonia appeared to be getting better, but he still had an unresolved patch in the lung. Suddenly his temperature rose to 105, and it appeared that further drainage was imperative. He was extremely exhausted. The question of the anæsthetic to be used in the case was a difficult one. Ether by inhalation was contra-indicated; chloroform was scarcely less desirable. Spinal analgesia was ruled out, as the spine was inaccessible. Accordingly colonic etherisation was employed, as the anus could be reached. It worked well, although some of the solution was returned during the course of the operation. A collection of pus was evacuated and the proximal portion of the urethra found. The amount of ether given in the control was very small. In such cases the control should be administered by the Shipway apparatus.

SUMMARY.

1. Ether in olive oil administered by the colon produces an anæsthesia characterised by an even, placid respiration of normal range; with an absence of venous and capillary congestion, and an absence of mucous secretion in the respiratory tract.

2. Cases have been reported in which the use of solutions with a high ether percentage—60 to 80 per cent.—has produced untoward symptoms, viz.:—primary respiratory failure during the course of anæsthesia, or the passage of blood from the rectum after operation.

3. These dangers can be avoided almost entirely by the use of the control method in which the strength of ether in the standard solution is 50 per cent., anæsthesia being completed and controlled by a limited amount of oral inhalation.

4. The success of the method depends on a strict adherence

to technique. Technique is everything. At the Richmond Hospital, Dublin, the preliminary medication and the injection is conducted by the Ward Sisters and Nursing Staff, acting under instruction as regards dosage and the time of administration. Such success as has attended the method at the hospital has been due to the care with which they have adhered to the technique of administration. Their cordial assistance merits the gratitude of those primarily responsible for the anæsthesia.

SUMMARY OF 138 CASES.

1. *General Surgery of the Head and Neck.*

Angioma of Tongue	...	...	...	1
Malignant Disease of Tongue	...	...	...	16
„ „ „ Floor of Mouth	...	...	...	10
„ „ „ Jaw and Floor of Mouth	...	...	...	1
„ „ „ Jaw	...	...	...	5
„ „ „ Hard Palate	...	...	...	1
„ „ „ Pharynx	...	...	...	1
„ „ „ Neck	...	...	...	2
„ „ „ Superior Maxilla	...	...	...	4
„ „ „ Glands in Neck	...	...	...	4
Epithelioma of Lip with Plastic Reconstruction	...	...	...	1
„ „ „ Lip with Glands	...	...	...	1
„ „ „ Nose	...	...	...	1
„ „ „ Ear	...	...	...	1
Sarcoma of Jaw	...	...	...	1
Cyst of Lower Jaw	...	...	...	1
Glands in Neck (non-malignant)	...	...	...	4
Abscess in Neck	...	...	...	1
Hodgkins' Disease (Neck)	...	...	...	1
Plastic post Burns, Face and Neck	...	...	...	1
Ulcer of Ear	...	...	...	1
Goitre (various types)	...	...	...	14
Abscess of Thyroid Isthmus	...	...	...	1
Tumour of Cervical Sympathetic	...	...	...	1

2. *Special Surgery of Throat, Nose and Ear.*

Plastic of Palate post G. S. W.	...	...	1
Cleft Palate	...	...	3
Maxillary Antrum	...	...	11
Frontal Sinus	...	...	2
Sphenoidal Sinus	...	...	2
Mastoid	...	...	4
Laryngo-fissure	...	...	2
Exploration of Air Passages	...	...	1
Submucous Resection of Septum Nasi	...	...	1
Turbinectomy	...	...	1

3. *Surgery of the Cranium and Brain.*

Craniotomy	...	...	3
Exploration of Brain	...	...	2
Cerebral Cyst Opened	...	...	1
Laceration of Brain	...	...	1
Brain Tumour	...	...	5
Ventriculography	...	...	3
Decompression	...	...	4
Exploration of Pituitary Fossa	...	...	2
Gasserian Ganglion	...	...	4

4. *General Surgery.*

Laminectomy	...	...	4
Thoracoplasty—removal of F.B.	...	...	1
Endothelioma of Pleura	...	...	1
Tumour of Breast	...	...	2
Tubercular Testis and Tubercular Disease of Lungs	...	...	1
Laceration of Urethra with Fracture of Pelvis and Femur	...	...	1

BOOKS.

THIS MONTH'S SPECIAL REVIEWS.

Papers from the Mayo Foundation and the Medical School of the University of Minnesota. Vol. I. W. B. Saunders Co., Philadelphia & London, 1921.

THE appearance of a fresh volume of the "Mayo Clinics" is always one of the events of the surgical literary year. Henceforward, in addition to the well-known red volume, we are to have a sister-publication, becomingly clothed in blue, the "Papers from the Mayo Foundation." An arrangement has been come to whereby the clinical and laboratory resources at Rochester have been made available for research purposes to graduate students proceeding for higher medical and surgical degrees at the University of Minnesota. These "Papers," we are told in a preface, summarise most of the research work carried out by these students during the years 1915-1920.

"The first function of a true university is to train its best students to think, to ask and answer questions; its second, to publish the answers to the questions." The attacking of unsolved problems—in other words, the active process of research—is the surest indication of the vitality of the teaching in any college. The coming into existence of the Mayo Foundation brings the University of Minnesota into line with the foremost medical teaching centres in the New World and the Old.

The number and extreme diversity of subjects chosen, ranging as these papers do, from a description of the "Morphology of the Digestive Tract in a Pig Embryo" to a study of the "Effects of Transition on the Pregnant Rat," constitute a very serious difficulty for the reviewer. A brief summary of some papers of surgical interest is given, not with the desire to overlook or disparage those of a purely medical concern, but simply because the writer feels himself incompetent to make any pronouncement as to their value and significance.

Dr. Paul White's investigations on gastric acidity following on gastroenterostomy confirms largely Paterson's conten-

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tion as to the physiological value of this operation. White shows that after gastroenterostomy there is an average 50 per cent. reduction of acidity, mainly in the free acid, and draws the conclusion that the operation causes relief (he does not say "cure") "by producing a rupture of the vicious circle of hypersecretion plus retention of acid content in contact with the ulcer area." Dr. Butsch has taken the much discussed subject of gastrojejunal ulcer for his thesis. Previous studies in the Mayo Clinic on this subject have already been published by Judd and Eustermann. As a result of experimental work on dogs, Butsch advances the novel hypothesis that the stomach reserves alkali for the body, so keeping the body tissues at a constant level of basic alkali, in order that the acid waste products may be removed. Neeve's study of the relationship of the gastroduodenal arterial supply to ulcer is a very thorough and painstaking piece of work, and might with advantage have been reproduced here in full.

Dr. Bumpus contributes an exhaustive study of the metastatic processes in carcinoma of the prostate: it is rather alarming to learn that in over 10 per cent. of cases the cancerous prostate has metastasized widely before giving rise to urinary symptoms. No less than one-third of the patients at the Clinic had long metastases demonstrable by *x*-ray at the time of their examination. The "small" cancerous prostate is the more malignant of the two known types. (In this connection, if the writer's memory be accurate, in 1913, Mr. Gunn, at the Royal Irish Academy of Medicine, was the first to point out that "the cancerous prostate is not necessarily an enlarged prostate.") Dr. Berkmann's study of surgical complications in diabetic patients is a hopeful one. Dr. Hedblom's analysis of the indications for the various operative procedures for the cure of chronic empyema, while containing nothing absolutely new, is a very clear and succinct presentation of a subject which hitherto has been the subject of much confusion of opinion. One of the best contributions to the whole volume is a detailed and lengthy report by Dr. Harrington on the effects on the kidney structure of various surgical procedures such as decapsulation, ureteric ligation, and trauma to the ureters; this is a true piece of surgical physiological pathology, and of immense value.

The different theses are here presented for the most part as "abstracts" or "abridgments"; in only a few cases is the original thesis reproduced in full. This manner of publication is likely to lead to disappointment amongst European readers, as many of the journals in which the original papers appeared *in extenso* may not be easily accessible to readers on this side of the Atlantic. An outstanding example of this drawback is the ruthless compression from which Miss Sanderson's studies on Basal Metabolism here suffer: another example of a similar grievance occurs in Miss Pettibene's researches on blood-coagulation in cases of jaundice. This, however, is but a minor drawback; for the rest, the publication is from the house of Saunders, which is to say that for form, type, and illustrations it cannot be excelled. We envy the Minnesota students their new-found opportunities, and look forward to their future publications with the greatest interest.

W.D.

Modern Methods in the Diagnosis and Treatment of Glycosuria and Diabetes. By HUGH MACLEAN, M.D., D.Sc., M.R.C.P. Pp. 159, with 13 charts and 9 figures. Publishers: Constable & Co. Price 12s.

THIS small monograph gives a short, concise, and clear account of present-day knowledge of diabetes and glycosuria in so far as the clinical aspect of these conditions is concerned. Special emphasis is laid on the importance of blood-sugar estimation, the technique of which is lucidly described. This may be undertaken by the medical man with only a small amount of essential chemical equipment, a small expenditure of time, and without any knowledge of special chemical methods apart from simple volumetric procedures. The amount of blood required for an estimation is only 0.2 c.c., and an accurate estimation may be carried out in twenty minutes. The modern dietetic treatment of diabetes is fully discussed, as are also acidosis and coma. The use of intravenous sodium bicarbonate in cases of diabetic coma is deprecated.

The author is to be congratulated on this work, which is up-to-date, accurate, lucid, and above all free from verbosity and padding.

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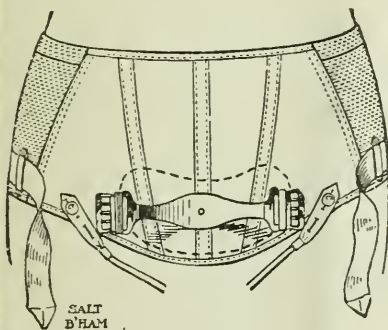
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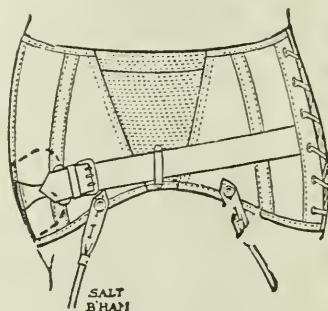
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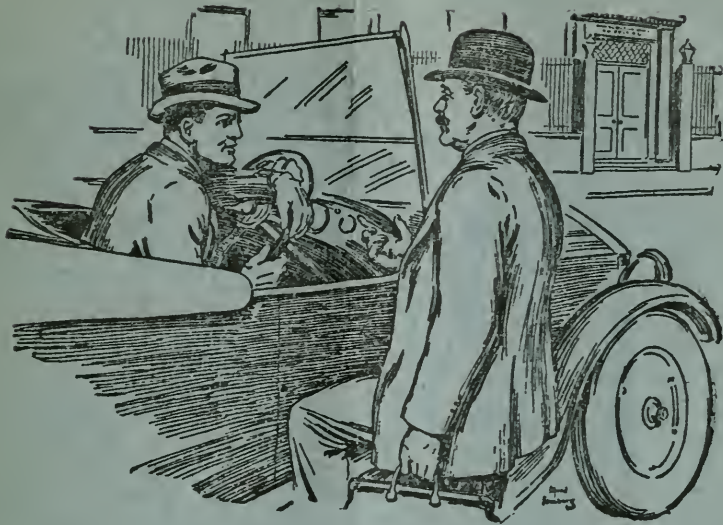
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